

Toxic effect of heavy metals in livestock health

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Introduction

Heavy metals constitute a very heterogeneous group of elements widely varied in their chemical properties and biological functions. The term "heavy metals" defined as commonly held for those metals, which have specific weights more than 5g cm⁻³ (Holleman and Wiverd, 1985). Heavy metals are kept under environmental pollutant category due to their toxic effects in plants, human and food. Some of the heavy metals i.e. arsenic (As), Cadmium (Cd), Lead (Pb), Mercury (Hg) are cumulative poison. These heavy metals are persistence, accumulate and not metabolized in other intermediate compounds and do not easily breakdown in environment. These metals are accumulating in food chain through uptake at primary producer level and then through consumption at consumer level. Metals are entering the human body either through inhalation or injection.

Heavy metals such as Cd, Ni, As, Pb pose a number of hazards to humans. These metals are also potent carcinogenic and mutagenic. Copper and zinc serve either as cofactor as a activator biochemical reactions & enzymatic for information of enzyme/ substrate metal complex (Mildvan, 1970). The high concentration intake of cadmium cause **itai itai** disease and mercury intake lead to **minamita** disease and other heavy metals cause poisoning due to drinking water contamination.

Heavy metals have largest availability in soil and aquatic ecosystem and to relatively smaller proportion in atmosphere at particular vapors. Metal toxicity to plants varies with plants species, specific metals, concentration, chemical form, soil

composition, pH and many metals considered to be essential for plants growth.

Source of contamination

Heavy metals pollution can originate from natural and anthropogenic sources. Activities such as mining & smelting operation and agriculture, have contaminated extensive area of world such as Japan, Indonesia, and China mostly such as Cd, Cu and Zn (Herawati et al., 2000) Cu and Pb in north Greece (Zantopoulos et al., 1999), Cu, Pb, Cu, Ni, Zn, and Cd in Austrilia (Smith et al., 1996). In animal body, metals are enter through animals feeds, green fodder, drinking water and pharmaceutical medicines etc. Other sources are accidental access to limed field, mineral supplements with high content of trace metal and licking of painted surfaced containing metallic pigments.

Classification of Heavy metal

Heavy metals can be classified into four major groups on their health importance.

Essential: Cu, Zn, CO, Cr, Mn and Fe . These metal also called micronutrients (Reeves and Baker, 2000) and are toxic when taken in excess of requirements (Monni et al., 2000; Blaylock and Huang, 2000). The toxic limit and recommended or safe intake of heavy metal for human health is given in Table- 1 (Oliver, 1997)

Non essential : Ba, Al, Li and Zr

Less toxic : Sn and Al

Highly toxic : Hg, Cd and Cd.

Heavy metals are also called trace element due to their presence in trace (10mg Kg⁻¹) or in ultratrace (1µg kg⁻¹) quantities in the environmental matrices.

Table-1: Toxic Limit and recommended / safe intake of heavy metal

Heavy Metal	Toxic Limit	Recommended intake / Safe intake
Arsenic	3 mg/day for 2-3 weeks	15 - 25 µg/day (adults)
Cadmium	200 µg/kg of fresh weight	15 -50 µg/day adults 2 -25 µg/day children,
Lead	≥ 500 µg/L (Blood)	20 - 280 µg/day adults 10 - 275 µg/day children
Zinc	150 µg/day	15 µg/day

Cadmium (Cd): Pure cadmium is a soft, silver-white metal. The physical property of cadmium is atomic number 48, atomic weight 112.411, electro-negativity 1.5, crystal ionic radius (Principal valence state) 0.97, ionisation potential 8.993, oxidation state +2, Electron configuration Kr 4d1 5S2 Density 8.64 g/cm3, Melting point 320.9°C and Boiling point 765°C at 100 kPa. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulphur (cadmium sulphate, cadmium sulphide).

Cadmium is a toxic to virtually every system in the animal body. It is almost absent in the human body at birth, however accumulates with age. An average man accumulates as about 30 mg cadmium in his body by the age of 50 years. Refined foods, water foods, water pipes, coffee, tea, coal burning and cigarettes are all the most important source of Cd. Daily dietary intake of Cd ranges from 40-50 µg/day (WHO, 1987). Cadmium accumulated in the kidney and liver over long time (McLaughlin et al., 1999). It interacts with numbers of minerals mainly Zn, Fe, Cu and Se due to chemical similarities and competition for binding stage. It is also reported that Cd can affect Ca, P and bone metabolism in both industrial and people exposed to Cd in general environment (Jarup et al., 1998).

Lead (Pb): Lead is a bluish or silvery grey soft metal with atomic number 82; atomic weight 207.19; specific gravity 11.34, melting point 327.5°C and boiling point 1740°C. It is the most common industrial metal that has become widespread in air, water, soil and food. Lead is slightly soluble in water and is transported mainly through the atmosphere. It behaves like calcium in body and accumulates in bone, liver, kidney and other tissues.

The problem of lead poisoning in animals has widely been recognized which needs a special attention for the environmentalist and health-personnel. It is a cumulative tissue poison and gets stored in different parts of the body especially in bones, liver, kidney and brain. Besides, direct ingestion of lead leading to increased blood lead levels, accumulated lead in the body also acts as a significant source of blood lead burden (Swarup et al., 2005). Accumulated lead is mobilized from the storage sites with decreasing blood lead level or following treatment with chelator, thus enhancing the chelator blood lead level without the animal being exposed to lead in the immediate past. Chelation treatment sometimes leads to fatal outcome due to

immediate surge of lead from the deposited site to blood causing severe damages to kidney and brain. Lead produces mainly acute or chronic poisoning. In acute lead poisoning case fatality in lead poisoning may go up to as high as 100%. In acute lead toxicity in cattle, there is sudden onset of signs and the animal at pasture may succumb within 24 hours.

Arsenic (As): The organoarsenicals in food are one of the most poisoning in livestock now a days because of the displacement of arsenic from almost all phases of farming activities. The common source of arsenic is in fluid used for dipping and spraying of animal to control ecto-parasites. Clinical signs of arsenic toxicity in cattle vary from gastrointestinal to nervous signs. Arsenic is a killer including sodium or sodium arsenate, Arsenic pentoxide and monosodium or disodium acid. It toxicity produces goiter in rats, thyroid antagonism in man and inhibited the growth of rumen bacteria in pure culture as well as reduces the fermentative activity. Chronic arsenic toxicity is mostly manifested in weight loss, capricious appetite, conjunctivitis and mucosal erythematous lesion including mouth ulceration and reduce milk yield. Acute toxic effects include abdominal cramping, hyperesthesia in extremities, abdominal patellar reflexes and abdominal electrocardiogram (Franzblau and Lillis, 1989). Such effects generally occur at the levels of exposure equal to 50 µg/kg weight/day. However, chronic poisoning of As includes anemia, liver and kidney damage, hyperpigmentation and keratosis i.e. skin damage (Wu et al., 1989; ATSDR, 2000).

It is reported that As toxicity produced goiter in rats, thyroid in man. Arsenic inhibited the growth of rumen bacteria in pure culture as well reduced the fermentative activity.

Mercury (Hg): Mercury is considered a highly toxic contaminant. The toxicity of mercury depends on its chemical form methyl mercury being the most hazardous metal and stable form of mercury that has been attributed to the suffering of most avian and mammalian predators at the top of contaminated tropics. Industrial wastes and sewage water from the chloroalkali industry are a major source of mercury pollution. The symptoms of toxicosis in most species of animals include incoordination of movement, visual aberration and decline in awareness. Fishes containing more than 0.4 ppm Hg are unfit for human consumption, the critical urinary concentration of Hg has been suggested as 1 to 2 µg/ml. Minamata disease is characterized by

symptoms of fatigue, loss of memory and concentration, tremors' constriction of visual field, cortical blindness etc. (Jarup, 2003). The intake of mercury as suggested by WHO is 43 µg (Krishnamurti, 1987). The animal consumed high mercury containing vegetation will be affected and will suffer from alopecia, neuropathy, visual and gastrointestinal tract disorder.

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Operation Flood made India one of the largest producer of milk in the world

Milk production was stagnant in India in the 1950s and 1960s. The Government wanted to increase milk production and improve its distribution in an attempt to alleviate poverty and mal-nutrition. For this, India received aid from the European countries through the World Food Programme.

The Government expended the money in an innovative and intelligent manner. Instead of distributing the gifts of milk and dairy products free, milk powder was used to manufacture liquid milk and sell it. The funds thus generated were invested in a project termed "Operation Flood". A National Milk grid was created, which linked milk producers throughout India. Milk production was encouraged through co-operatives of the milk producers. Dairy farmers benefited because they were not affected by seasonal and regional price fluctuations. The project was a huge success - it made India one of the largest producers of milk in the world. This was hailed as the "White Revolution".

The project was implemented in three phases. Phase one was from 1970 to 1980. It covered eight of India's major cities. Phase two was from 1980 to 1985. Milk sheds increased from 18 to 136. Urban markets expanded. There were 290 outlets. A self-sustaining system had been set up by the end of phase two. In phase three (between 1985 to 1996) there has been a further increase in milk co-operatives: 30,000 co-operatives have been added. The facilities have been expanded to provide veterinary care. Efforts are made to see that the cattle feed is of good quality. Research has been undertaken in the fields of animal breeding, animal health and nutrition.